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to remove; it has declared discontinuity where there is now proved continuity; it has postulated preformation where there is now evident epigenesis.

T. H. MORGAN.

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SOME EXPERIMENTS IN BREEDING SLUGS

Certain large naked mollusca or slugs, common in Europe, are noted for their numerous and striking color-variations, some of which seem to be correlated with climatic conditions. Little has been known concerning the inheritance of these color-forms, but Mr. Walter E. Collinge has recently made some experiments in breeding two of the species, *Arion ater* (or *empiricorum*) and *A. subfuscus*. The results of this work are given in the *Journal of Conchology*, the short paper containing them being Mr. Collinge's address as president of the Conchological Society, delivered October 17, 1908. As the publication is available to few in this country, and the facts cited are very interesting, it seems worth while to abstract part of them.

Arion ater is a very large and handsome slug, of which the following color-varieties were used or appeared in the experiments:

- (1) *ater*, pure black. I was not quite clear about the meaning

of the expression "typical," as used by Mr. Collinge, but in reply to my question, he writes that in every case it was "the pure black form, not *nigrescens* or *plumbea*."

(2) *castanea*, a brown variety.

(3) *rufa*, a red variety. The reddest forms occur on the continent of Europe. The above three have the body unicolorous, though the foot fringe may vary.

(4) *albolateralis*, with the back black and the sides white, the two colors sharply separated. A very handsome variety, of restricted range, especially common in Wales. Mr. Collinge writes me that the specimens he used were found in the vicinity of Birmingham.

(5) *scharffi*, like *albolateralis*, but the sides yellow instead of white.

In the first experiment, *castanea* was paired with *ater*, and the former laid 39 eggs, of which 24 were hatched and raised to maturity. These proved to be: 12 *ater* (with slight variations in foot fringe), 10 *rufa*, 2 *castanea*. From this lot, *rufa* was paired with *castanea*, and gave 14 in the next generation, of which four were *ater*, eight *rufa* and two *castanea*.

From the pairing of two of the eight *rufa*, fifteen slugs were raised, eight being *rufa*, two *ater*, and five subvarieties of *castanea*. (Mr. Collinge does not explicitly state eight *rufa*, but in a letter he confirms this interpretation of his account.) From the pairing of two *rufa* of the last generation sixteen adults were raised, twelve being *ater*, two subvarieties of *rufa*, and two subvarieties of *castanea*. Thus the experiment was carried to F₄, with results which are thoroughly Mendelian so far as the segregation of characters goes, but difficult to explain in regard to the appearance and proportions of the different kinds. It will be noted that *rufa* was twice chosen for breeding, to the exclusion of the other varieties, and the second time gave many more black slugs than the first. None of the bicolored forms appeared.

In a second experiment two *albolateralis* were paired, giving a progeny of 22 slugs, 20 being *ater* and 2 *scharffi*. This is so extraordinary that I asked Mr. Collinge particularly about it, and he confirms the result as stated. One would expect *albolateralis* to be homozygous, but the experiment shows that it is either heterozygous (in which case the proportions are hard to explain) or the results are incapable of explanation by any

ordinary hypothesis. I can not help suspecting that the parent slug had really paired earlier with a specimen of *ater*, the progeny in consequence not actually having the origin stated. In that case, supposing *ater* to be dominant, the results would not be so anomalous. It is not so easy to explain the results of the first experiment by the hypothesis of previous pairing, as in that, except for the original pair, the slugs were under observation from their birth.

Seeking a possible explanation of the *albolateralis* case, I consulted Dr. C. B. Davenport, who practically concurs with my view, writing: "The result of Collinge's mating is inexplicable to me except upon one or the other of two hypothesis; either that the parents were heterozygous or else, as you suggest, the supposed parents were not the actual ones, and one had previously paired with a black slug. Of course if *albolateralis* is a heterozygote, then striping is dominant as is usually the case and uniformity recessive. Uniform black would then be active in one quarter of the offspring, but the great proportion of pure black speaks against this hypothesis" (litt., March 22, 1909).

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